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PSEUDANTHESSIUS PROCURRENS N.SP., A CYCLOPOID COPEPOD ASSOCIATED WITH A CIDARID ECHINOID IN MADAGASCAR

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INTRODUCTION

During an extensive search in 1963-64 for copepods associated with marine invertebrates at Nosy Bé, in northwestern Madagascar, 109 adults and 9 copepodids of the new lichomolgid copepod described below were recovered from the sediment obtained after washing 30 large pencil urchins, *Phyllacanthus imperialis* (Lamarek), in weakly alcoholized sea water. (The host echinoid is widespread in the Indo-Pacific region, where it occurs, for example, in Australia, the Marshall Islands, the Philippine Islands, Ceylon, the Red Sea, and Zanzibar). This new form brings the total number of species known in the genus *Pseudanthessius* to 24 (including the 22 species listed by Stock, Humes, and Gooding, 1963, and a new species from a polychaete annelid in Madagascar whose description by Humes and Ho is in press).

ACKNOWLEDGMENTS

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I wish to thank Dr. H. Barraclough Fell, Professor of Invertebrate Zoology at the Museum of Comparative Zoology, for the identification of the echinoid host, and to acknowledge the assistance to the field work given by the staff of the Centre d'Océanographie et des Pêches at Nosy Bé.

DESCRIPTION

Family LICHOMOLGIDAE Kossmann, 1877

Genus PSEUDANTHESSIUS Claus, 1889

PSEUDANTHESSIUS PROCURRENS¹ n.sp.

Figures 1-29

Type material. — 16 females, 9 males, and 1 copepodid from washings of 3 pencil urchins, *Phyllacanthus imperialis* (Lamarck), in 1 meter depth among dead coral (*Acropora*) at Pte. Ambarionaomby, Nosy Komba, near Nosy Bé, Madagascar. Collected November 28, 1963. Holotype female, allotype, and 19 paratypes (13 females and 6 males) deposited in the U. S. National Museum, Washington, and the remaining paratype adults (dissected) together with the copepodid in the collection of the author.

Other specimens (all from *Phyllacanthus imperialis* collected in 1963 at the type locality). — 2 females from 1 host, July 3; 10 females and 7 males from 3 hosts, July 18; 14 females and 5 males from 6 hosts, August 23; 13 females, 6 males, and 4 copepodids from 7 hosts, October 30; and 16 females, 11 males, and 4 copepodids from 10 hosts, December 14. This last collection is deposited in the Museum of Comparative Zoology.

Female. — The body (Figs. 1 and 2) has a broadened prosome. The length (excluding the setae on the caudal rami) is 0.95 mm (0.90-1.01 mm) and the greatest width is 0.44 mm (0.42-0.46 mm), based on 10 specimens. The ratio of the length to the width of the prosome is 1.28:1. The segment bearing leg 1 is almost completely fused with the head, the only indication of separation being a short weak crease on each side. The lateral areas of the metasomal segments are rounded.

The segment of leg 5 (Fig. 3) is expanded laterally, being 50 μ in length and 133 μ in width. Between the segment of leg 5 and the genital segment there is a ventral intersegmental sclerite (see Fig. 2). The genital segment (Fig. 3) is 127 μ long. Anteriorly its lateral margins form 2 rounded, strongly sclerotized lobes (the width of the segment at this level being 115 μ). The width at the level of the dorsolateral areas of attachment of the egg sacs is 107 μ . Behind each attachment area the segment is slightly

¹ The specific name *procurrens*, from Latin *procurrere*, meaning to bulge out or project, alludes to the outer expansion on the coxa of leg 1 and to the 2 rounded lobes on the anterior part of the genital segment in the female.

constricted with nearly parallel margins (the width in this region being $86\ \mu$). Each egg sac attachment area (Fig. 4) bears anteriorly a slender, slightly haired seta ($21\ \mu$ long) and just posterior to it a short naked seta ($6.5\ \mu$ long) composed of an expanded sclerotized basal portion and a slender hyaline distal part. Medial to the latter seta there are 2 small spinelike processes. The three postgenital segments are 44×81 , 39×75 , and $65 \times 72\ \mu$ from anterior to posterior. The anal segment bears on each side on its distal margin a dorsal and ventral row of spinules.

The caudal ramus (Fig. 5) is elongated, with a terminal ventral expansion whose margin bears a row of spinules. The length along the inner side of the ramus to the end of the expansion is $114\ \mu$, along the outer side $104\ \mu$, and the width at the level of the outer seta is $24\ \mu$. The ratio of length to width is about 4.5:1. The outer seta, inserted $70\ \mu$ from the base of the ramus, is naked and $56\ \mu$ in length. The pedicellate dorsal seta is $33\ \mu$ and slightly haired. The outermost terminal seta ($100\ \mu$) and the innermost terminal seta ($72\ \mu$) are haired. The 2 long median terminal setae are 177 and $250\ \mu$ in length respectively and haired. A minute lateral setule is borne on the outer basal margin of the ramus. The dorsal and ventral surfaces of the ramus bear a few refractile points.

The dorsal surface of the prosome and the dorsal and ventral surfaces of the urosome bear minute setules and refractile points. In addition, the outer ventral areas of the head carry a submarginal row of refractile points (Fig. 6). The ratio of the length of the prosome to that of the urosome is 1.53:1.

The egg sacs (Fig. 1) are moderately elongated, often rather pointed posteriorly, and contain numerous eggs. In one female the egg sacs measured $385 \times 220\ \mu$, with each egg about 57 - $60\ \mu$ in diameter.

The rostral area (Fig. 7) is moderately well developed. Between this area and the front of the labral region there is a slight protrusion on the ventral surface of the head.

The first antenna (Fig. 8) is 7-segmented, with the lengths of the segments (measured along their posterior non-setiferous margins) 24 ($39\ \mu$ along the anterior margin), 103 , 21 , 39 , 33 , 20 , and $17\ \mu$ respectively. The formula for the armature is 4 , 13 , 6 , 3 , $4 + 1$ aesthete, $2 + 1$ aesthete, and $7 + 1$ aesthete. All the setae are naked.

The second antenna (Fig. 9) is 4-segmented, with the last segment elongated ($69\ \mu$ along the shorter ventral margin, $93\ \mu$ along

the dorsal margin, and 19 μ in width). Each of the first two segments bears a small ventral seta, the third segment bears 4 slender setae (one of them very small), and the last segment bears 2 unequal slender recurved claws (47 and 25 μ respectively along their axes) and 5 setae, one of them very long (99 μ). The extremity of the last segment is swollen, so that the 2 claws insert at one side rather than directly on the tip of the segment. All the setae are naked.

The labrum (Fig. 10) consists of 2 diverging, pointed lobes with their medial edges straight and finely dentate, both arising from a large, conspicuous, sclerotized area which projects (Fig. 2) from the ventral surface of the head. On the posterior wall of the labrum, in front of the mouth area, there is a pair of small sclerotized lobes. The surface of the labrum lacks fine ornamentation.

The mandible (Fig. 11) has on the concave side of the blade an oblique row of spinules followed distally by a spinelike process lying parallel to the blade and evidently not articulated with it. The convex side of the blade bears a fringe of graduated spinuliform structures without definite articulations. The paragnath (Fig. 12), lying medial to the base of the first maxilla (as in Fig. 16), is a rounded lobe bearing a small sclerotized outer process, a small postero-inner knob, and a posterior group of hairs. The first maxilla (Fig. 13) is a single segment bearing 4 naked elements, comprising terminally 2 obtuse subequal spines (10 and 8 μ long) and a shorter pointed spine (5 μ) and subterminally a naked hyaline seta (11 μ). The second maxilla (Fig. 14) is 2-segmented. The first segment is unarmed but has a small sclerotized protuberance on its expanded margin. The second segment is produced to form a long bilaterally spinulose lash; the dorsal surface bears a proximal seta 29 μ in length (bearing lateral spinules along one edge) and a distal row of 3-5 spinules. The maxilliped (Fig. 15) is 3-segmented. There are 2 naked setae on the second segment. The terminal segment bears proximally a spine with unilateral spinules, a hyaline naked setule, and near the base of the latter a minute setule; the segment is produced to form an attenuated spinelike structure with a row of long spinules along one side and a row of minute spinules near the opposite margin.

The postoral area (Fig. 16) shows between the paragnaths a shield-shaped area which projects ventrally to form a low median process. Posterior to the sclerotization which almost joins the

bases of the maxillipeds, the ventral surface of the cephalosome protrudes slightly (best seen in a lateral view, as in Fig. 2).

Legs 1-4 (Figs. 17, 18, 19, and 20) have trimerous rami except for the endopod of leg 4 which is unimerous. The armature of the legs is as follows (the Roman numerals indicating spines, the Arabic numerals setae) :

P 1	protopod	0-1;	1-0	exp	I-0;	I-1;	III,I,4
				end	0-1;	0-1;	I,2,3
P 2	protopod	0-1;	1-0	exp	I-0;	I-1;	III,I,5
				end	0-1;	0-2;	I,II,3
P 3	protopod	0-1;	1-0	exp	I-0;	I-1;	III,I,5
				end	0-1;	0-2;	I,II,2
P 4	protopod	0-1;	1-0	exp	I-0;	I-1;	II,I,5
				end	II		

The inner seta on the coxa of legs 1-3 is long and plumose, but in leg 4 this seta is minute (7 μ long) and naked. In the first 3 legs the inner margin of the basis bears a short row of hairs, but in leg 4 these hairs are lacking. The outer coxal margin of leg 1 is expanded to form a prominent lobe (Fig. 17); in legs 2 and 3 this expansion is much less prominent and in leg 4 it is apparently absent. The tips of the outer spines on the exopods are slightly recurved posteriorly and the more proximal ones have minute terminal flagella. The 3 spines on the last segment of the endopod of leg 2 are 14, 10, and 13 μ in length from proximal to distal, with the middle one having a short terminal flagellum. In leg 4 the exopod is longer than in any of the preceding legs. The endopod measures 53 x 16 μ and has nearly parallel margins without a constriction or notch. It bears a row of hairs on its outer proximal third and an anterior row of small spinules near the insertions of the 2 divergent terminal spines (the outer 18 μ long with a minute flagellum, the inner 37 μ long with a more strongly spinulose flange along the outer side than along the inner side).

Leg 5 (Fig. 21) consists of a strong spine (33 μ long) and an adjacent seta (21 μ), together with a dorsal seta (22 μ), ornamented as in the figure. External to the spine and seta there is a row of minute blunt spinules at the apex of the segment. Although, as in other species of *Pseudanthessius*, there is no free segment of leg 5, it is likely that the spine and its adjacent seta correspond to the terminal armature in other lichomolgids.

Leg 6 is probably represented by the 2 setae near the attachment of each egg sac (see Fig. 4).

The color in life in transmitted light is translucent, the eye red, the intestine black, the ovary gray, the egg sacs opaque gray. (Although in specimens preserved in 70 per cent ethyl alcohol the color is an opaque grayish brown, the color changes quickly to a bright red when the copepods are placed in lactic acid.)

Male.—The body (Figs. 22 and 23) has a much narrower prosome than in the female, but otherwise resembles that sex in general form. The length (not including the setae on the caudal rami) is 0.76 mm (0.73-0.78 mm) and the greatest width is 0.27 mm (0.25-0.28 mm), based on 10 specimens (including the allotype, 8 paratypes, and 1 specimen from Pte. Ambarionaomby on October 30). The ratio of length to width of the prosome is 1.57:1.

The segment of leg 5 is similar to that of the female, and measures $31 \times 94 \mu$. The genital segment (Fig. 24) is nearly as long as wide, $104 \times 110 \mu$, and in dorsal view has a subspherical outline. In lateral view (Fig. 25) the anteroventral part of the segment projects noticeably. There is no intersegmental sclerite between the segment of leg 5 and the genital segment. The 4 postgenital segments are 39×52 , 32×51 , 30×50 , and $43 \times 53 \mu$ from anterior to posterior.

The caudal ramus resembles that of the female, but is a little shorter, the inner length being 78μ , the outer length 73μ , the width 23μ , and the ratio of length to width 3.26:1.

The surfaces of the prosome and urosome bear minute setules as in the female. The ratio of the length of the prosome to that of the urosome is 1.31:1.

The rostral area, first antenna, second antenna, labrum, mandible, paragnath, and first maxilla are like those in the female. The second maxilla also resembles that of the female, but lacks the small sclerotized protuberance on the expanded margin of the basal segment. The maxilliped (Fig. 26) is much elongated, slender, and 4-segmented (assuming that the fourth segment is represented by the proximal part of the claw). Its entire length including the claw is about 300μ . The first segment is unarmed. The second bears 2 unequal inner setae and 2 rows of hairs, one along the inner margin distal to the setae and another starting on the proximal inner margin and passing obliquely to the distal posterior surface of the segment. The very short third segment is unarmed. The terminal recurved claw, 135μ in length along its axis, bears a conspicuous terminal lamella. The slightly crenated fringe along its concave margin is interrupted about midway. Near the base of the claw on its posterior surface there is a seta

42 μ long with minute lateral spinules, and on its anterior surface there are 2 small naked setules, one 10 μ , the other 4 μ long.

The postoral area is like that of the female.

Legs 1-4 resemble those of the female except that the last segment of the endopod of leg 1 is more elongated (Fig. 27), and the terminal segment of the endopod of leg 2 is more elongated, and its 3 spines are longer (24, 22, and 25 μ from proximal to distal), as seen in Figure 28.

Leg 5 is similar to that of the female.

Leg 6 (Fig. 29) consists of a posteroventral flap on the genital segment. Beyond the rim of the segment the leg projects conspicuously (see Fig. 24) as a large, pointed, ventral sclerotized process dorsal to which there is a shorter rounded process bearing 2 naked setae 22 and 24 μ in length.

The spermatophore, seen only inside the body of the male (Fig. 24), is oval, about 72 x 45 μ , with a short neck.

The color in life in transmitted light resembles that of the female.

RELATIONSHIP TO OTHER SPECIES IN THE GENUS

Twelve species of *Pseudanthessius* may be readily distinguished from *P. procurrans* in that they lack the prominent outer expansion on the coxa of leg 1 and do not bear the two rounded sclerotized lobes on the anterior part of the genital segment in the female. These species are: *P. aestheticus* Stock, Humes, and Gooding, 1963, *P. concinnus* Thompson and A. Scott, 1903, *P. deficiens* Stock, Humes, and Gooding, 1963, *P. dubius* G. O. Sars, 1918, *P. graciloides* Sewell, 1949, *P. luculentus* Humes and Cressey, 1961, *P. mucronatus* Gurney, 1927, *P. nemertophilus* Gallien, 1935, *P. notabilis* Humes and Cressey, 1961, *P. pectinifer* Stock, Humes, and Gooding, 1963, *P. tortuosus* Stock, Humes, and Gooding, 1963, and a new species (Humes and Ho, in press) from a polychaete annelid in Madagascar.

Eight other species may be separated from *P. procurrans* in that they lack the two lobes on the anterior part of the genital segment in the female and have a different armature on the last segment of the second antenna. (Unfortunately, in the original descriptions of these species, definite information on the condition of the outer coxal margin of leg 1 was not given.) These species are: *P. gracilis* Claus, 1889, *P. latus* Illg, 1950, *P. obscurus* A. Scott, 1909, *P. sauvagei* Canu, 1892, *P. spinifer* Lindberg 1945, *P. tenuis* Nicholls, 1944, *P. thorelli* (Brady, 1880), and *P. weberi* A. Scott, 1909.

Three species remain to be compared with *P. procurrens*: *P. liber* sensu Sewell, 1949, *P. liber* (Brady, 1880), and *P. assimilis* G. O. Sars, 1917. The species referred to as *P. liber* (Brady and Robertson) by Sewell (1949) is probably a new and unnamed species of the genus (see Humes and Cressey, 1961, pp. 80-81). It differs from *P. procurrens* chiefly in the presence of two long elements (aesthetes ?) on the basal segment of the first antenna, in the inwardly curving terminal spine on the last segment of the exopod of legs 2-4, and in the notch on the outer margin of the endopod of leg 4. No information was given for this form regarding the nature of the genital segment in the female, and the condition of the outer coxal margin of leg 1 is not clearly shown in Sewell's text figure 32 D.

P. liber (Brady, 1880)² lacks the two lobes on the anterior part of the genital segment of the female, has a caudal ramus about twice as long as wide, and has a different armature on the last segment of the second antenna. Brady did not mention an outer coxal expansion on leg 1, but Sars (1917) both mentioned and figured such an expansion in specimens taken in Norway. The expansion illustrated on Sars' plate XCIV is, however, less pronounced than in *P. procurrens*. The armature for the last segment of the endopod of leg 3 in the female is, according to Sars, I,II,3, instead of I,II,2 as in the Madagascan species.

P. assimilis G. O. Sars, 1917, is said by Sars to be closely allied to *P. liber* (Brady, 1880). Like the latter species it lacks the two lobes on the genital segment of the female and has an armature on the last segment of the second antenna unlike that of *P. procurrens*. Sars stated that the legs are "almost exactly as in *P. liber*," implying that there is a similar outer coxal expansion on leg 1.

Judging from the available information, *P. procurrens* appears to be near both *P. liber* (Brady, 1880) and *P. assimilis* G. O. Sars, 1917, resembling them in having an outer coxal expansion on leg 1, but differing in having two lobes on the anterior part of the genital segment in the female and in having a different armature on the last segment of the second antenna.

SUMMARY

The new species *Pseudanthessius procurrens* is associated with the cidarid echinoid *Phyllacanthus imperialis* (Lamarek) in the

² Not Brady and Robertson, 1876. See Stock, Humes, and Gooding, 1963, p. 10, footnote.

region of Nosy Bé, northwestern Madagascar. Within the genus the copepod may be recognized by the conspicuous expansion on the outer coxal area of leg 1 and by the two rounded lateral lobes on the anterior part of the genital segment in the female. The species nearest to the new form appear to be *P. liber* (Brady, 1880) and *P. assimilis* G. O. Sars, 1917. Although the host echinoderm is widely distributed in the Indo-Pacific area, the new copepod associated with it is known at present only from the type locality in Madagascar.

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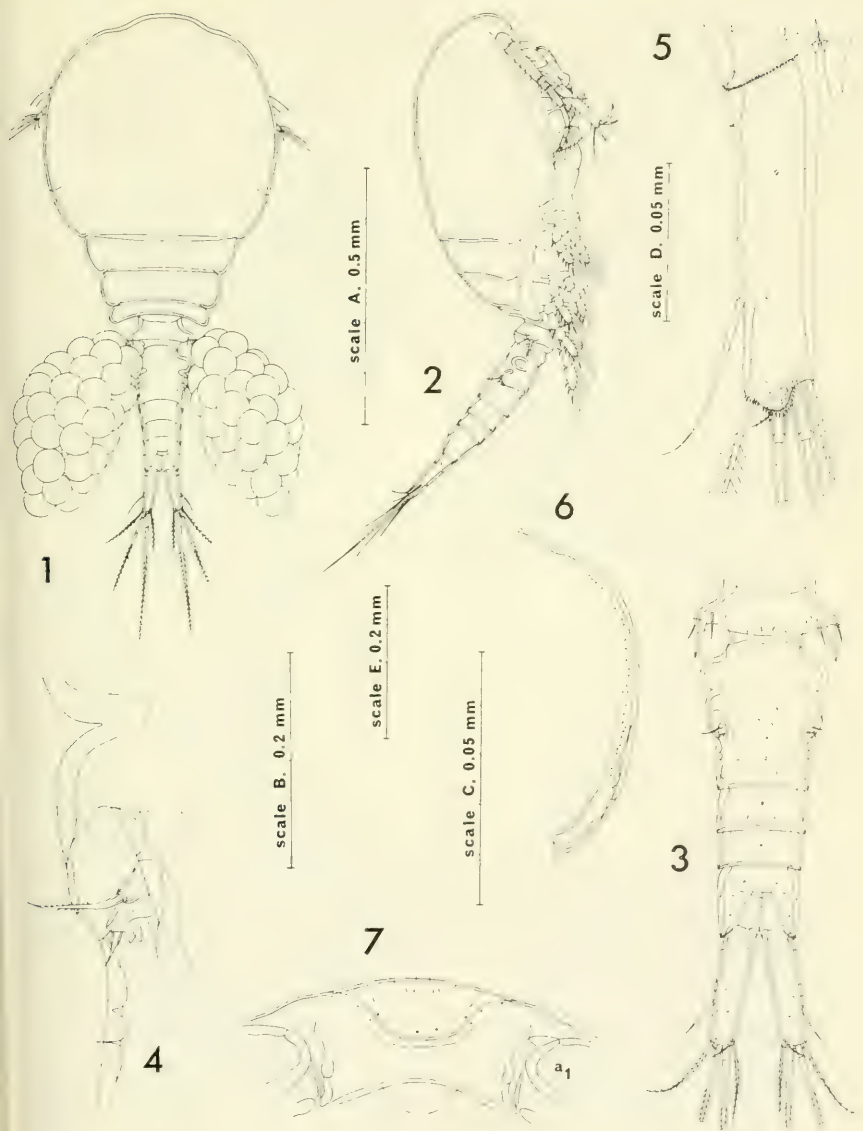
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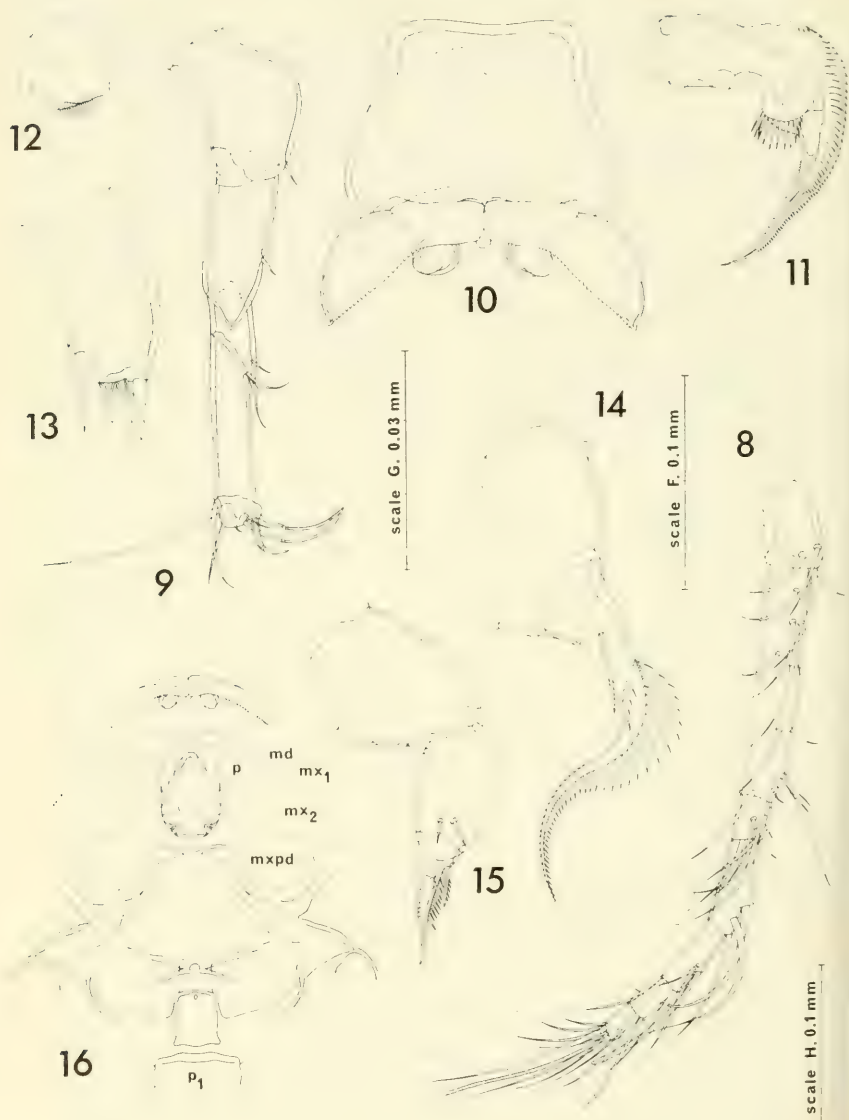
EXPLANATION OF THE FIGURES

All the figures have been drawn with the aid of a camera lucida. The letter after the explanation of each figure refers to the scale at which the figure was drawn.

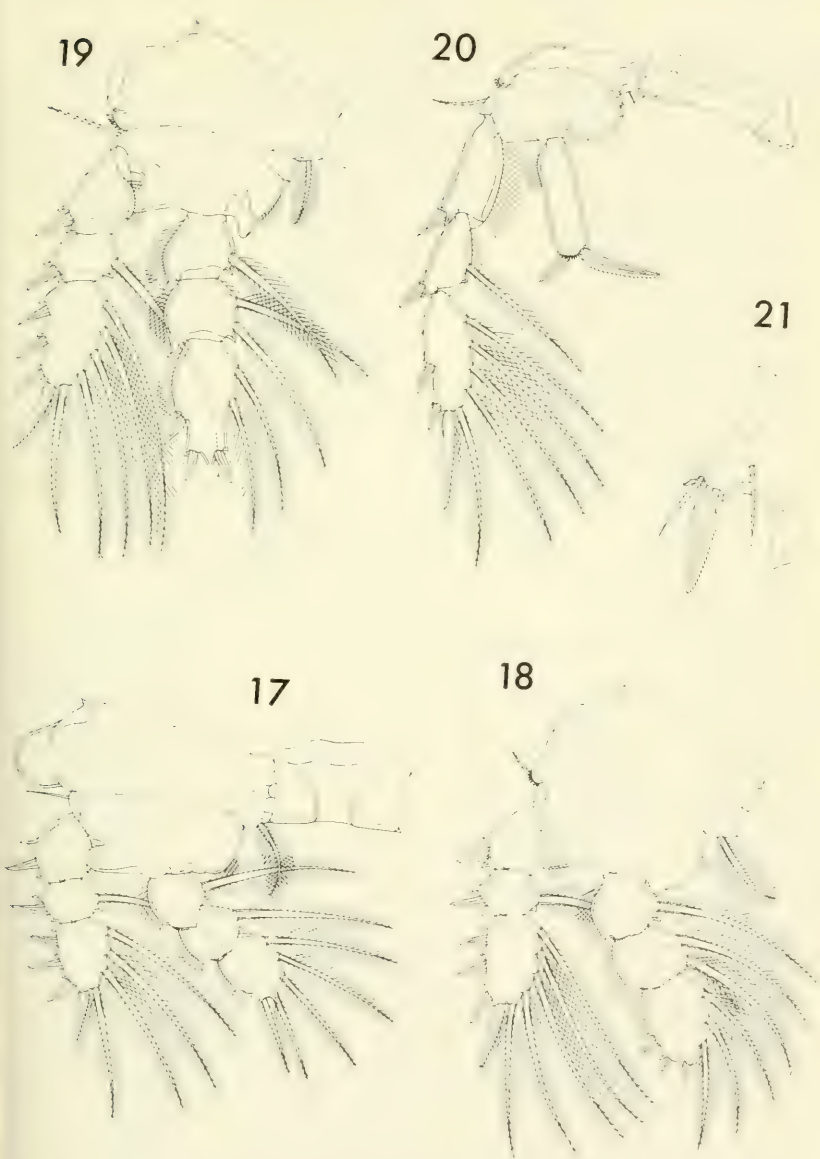
Abbreviations: a_1 = first antenna, md = mandible, p = paragnath, mx_1 = first maxilla, mx_2 = second maxilla, mxpd = maxilliped, p_1 = leg 1.



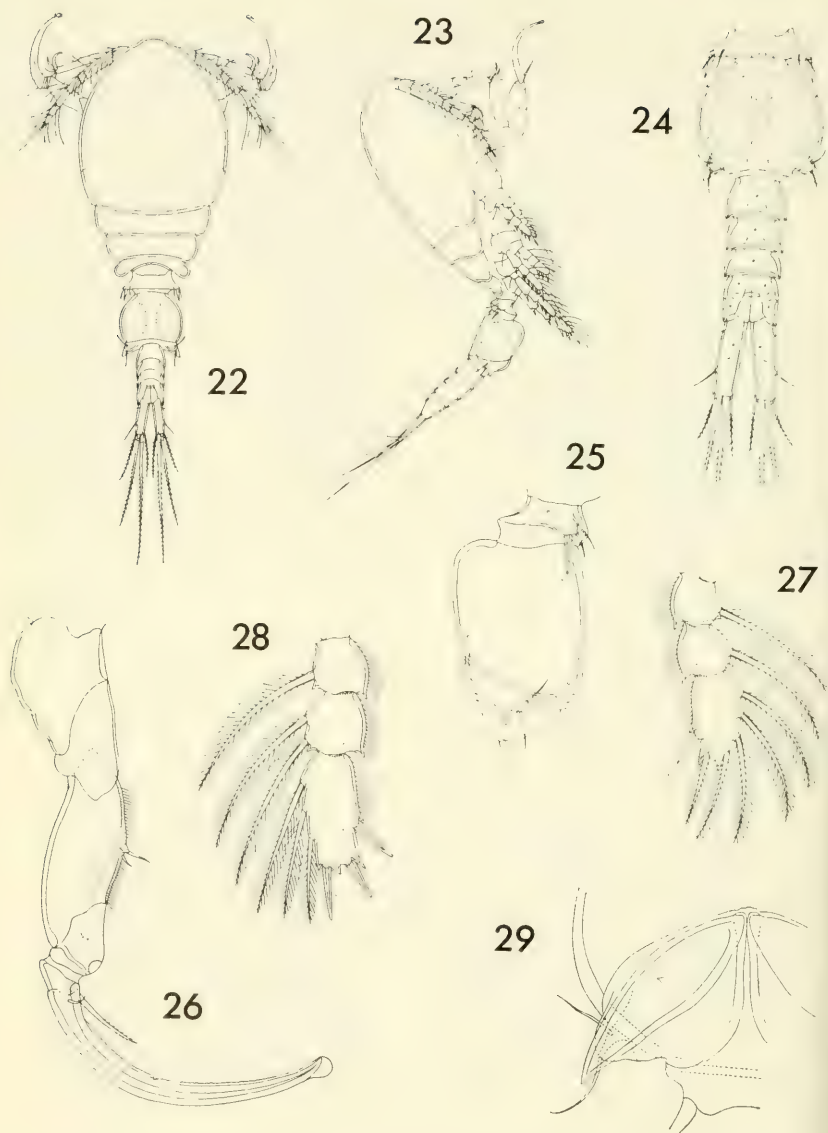
FIGURES 1-7. *Pseudanthessius procurrens* n.sp., female. 1, dorsal (A); 2, lateral (A); 3, urosome, dorsal (B); 4, area of attachment of egg sac, dorsal (C); 5, caudal ramus, ventral (D); 6, edge of cephalosome, ventral (E); 7, rostral area, ventral (F).



FIGURES 8-16. *Pseudanthessius procurrens* n.sp., female (continued). 8, first antenna, anterodorsal (F); 9, second antenna, inner (F); 10, labrum, ventral (D); 11, mandible, inner (D); 12, paragnath, ventral (D); 13, first maxilla, outer (G); 14, second maxilla, dorsal (D); 15, maxilliped, inner (D); 16, postoral area, ventral (H).



FIGURES 17-21. *Pseudanthessius procurrens* n.sp., female (continued). 17, leg 1, anterior (F); 18, leg 2, anterior (F); 19, leg 3, posterior (F); 20, leg 4, anterior (F); 21, leg 5, dorsal (D).



FIGURES 22-29. *Pseudanthessius procurrens* n.sp., male. 22, dorsal (A); 23, lateral (A); 24, urosome, dorsal (B); 25, genital segment, lateral (H); 26, maxilliped, anterior (F); 27, endopod of leg 1, anterior (F); 28, endopod of leg 2, anterior (F); 29, leg 6, ventral (D).